CLAIMS

What is claimed is:

1. A composite gel comprising:

a) a dispersed phase comprising lipid droplets or particles;

b) a continuous phase aqueous matrix comprising one or more cross-linked proteins; and,

c) supplemental constituents;

wherein the dispersed phase is embedded within the continuous phase matrix; and, whereby supplemental constituents or lipid droplets, suitable for ruminant ingestion, are protected against degradation, modification, or removal during passage through a rumen.

2. The composite gel of claim **1**, wherein the supplemental constituents are selected from the group consisting of vitamins, nutrients, proteins, amino acids, polyunsaturated lipids, minerals, bioactive materials, and pharmaceuticals.

3. The composite gel of claim **1**, wherein the supplemental constituents are in the dispersed phase.

4. The composite gel of claim **1**, wherein the supplemental constituents are in the continuous phase matrix.

5. The composite gel of claim **1**, wherein the lipid droplets range in size from about 0.1 μm to about 50 μm.

6. The composite gel of claim **5**, wherein the lipid droplets range in size from about 0.1 μm to about 1 μm.

7. The composite gel of claim **5**, wherein the lipid droplets comprise a specific surface area of more than about 10 m^2/ml of filler phase.

8. The composite gel of claim **1**, wherein the lipid droplets comprise one or more oils, fats, monoglycerides, diglycerides, triglycerides, or free fatty acids.

9. The composite gel of claim **1**, wherein the lipid comprises about 10% to about 50%, or more, conjugated linoleic acid.

10. The composite gel of claim **9**, wherein the lipid comprises about 25%, or more, conjugated linoleic acid.

11. The composite gel of claim **1**, wherein the dispersed phase lipid comprises oil selected from the group consisting of corn oil, poppy seed oil, fish oil, cotton seed oil, soybean oil, walnut oil, safflower oil, sunflower oil, sesame oil, canola oil, linseed oil, whole or modified oil seed, whole or modified beans, grape seeds, cotton seeds, safflower seeds, algae, microorganisms, yeasts, and protozoa.

12. The composite gel of claim **1**, wherein the lipid comprises fatty acids selected from the group consisting of oleic acid, conjugated linoleic acid, linolenic acid, phytanic acid, omega 3 fatty acids, docosahexaenoic acid, and eicosapentaenoic acid.

13. The composite gel of claim **1**, further comprising one or more emulsifiers.

14. The composite gel of claim **1**, further comprising one or more hydrocolloids.

15. The composite gel of claim **1**, wherein the proteins are selected from the group consisting of whey proteins, bovine blood plasma proteins, gelatin, peanut proteins, cereal proteins, fish proteins, soy proteins, and porcine blood proteins.

16. The composite gel of claim **1**, wherein the continuous phase matrix is resistant to conditions found in a rumen.

17. The composite gel of claim **1**, wherein the continuous phase further comprises one or more reducing sugars.

18. The composite gel of claim **17**, wherein the reducing sugars are selected from the group consisting of glucose, lactose, fructose, mannose, maltose, ribose, and galactose.

19. The composite gel of claim **1**, wherein the proteins are cross-linked by reducing sugars.

20. The composite gel of claim **1**, wherein the proteins are cross-linked by heat induced formation of disulfide bonds between the proteins.

21. The composite gel of claim **1**, wherein the proteins are predominantly cross-linked by disulfide bonds, hydrophobic interactions, ionic interactions, or hydrogen bonding.

22. The composite gel of claim **1**, wherein the continuous phase comprises about 10% to about 50% total solids by weight.

23. The composite gel of claim **22**, wherein the total solids comprise about 10% to about 100% protein by weight.

24. The composite gel of claim **22**, wherein the total solids comprises about 0% to about 50% reducing sugars by weight.

25. The composite gel of claim **1**, wherein the continuous phase comprises about 10% to about 95% water.

26. The composite gel of claim **1**, wherein the continuous phase comprises calcium, magnesium, sodium, or phosphate.

27. A method of preparing a rumen protected composite gel, the method comprising:

a) preparing a matrix suspension by dissolving or suspending matrix constituents in water, which constituents comprise one or more proteins;

b) preparing a filler composition by mixing filler components, which components comprise one or more lipids;

c) emulsifying the filler composition into the matrix suspension; and,

d) heating the emulsion to produce a composite gel;

whereby the composite gel is protected from degradation in a rumen.

28. The method of claim **27**, wherein the proteins are selected from the group consisting of a whey protein, a bovine blood plasma protein, gelatin, a peanut protein, a cereal protein, a fish protein, a soy protein, and a porcine blood protein.

29. The method of claim **27**, wherein the matrix constituents further comprise a reducing sugar.

30. The method of claim **29**, wherein the reducing sugars are selected from the group consisting of glucose, lactose, fructose, mannose, maltose, ribose, and galactose.

31. The method of claim **27**, wherein the matrix suspension constituents do not comprise reducing sugars in an amount effective to significantly cross-link matrix proteins under conditions of the method.

32. The method of claim **27**, wherein the matrix constituents further comprise supplemental constituents selected from the group comprising vitamins, nutrients, minerals, proteins, amino acids, bioactive materials, and pharmaceuticals.

33. The method of claim **27**, wherein the filler components further comprise supplemental constituents selected from the group comprising vitamins, polyunsaturated lipids, nutrients, amino acids, minerals, bioactive materials, and pharmaceuticals.

34. The method of claim **27**, wherein the filler components or matrix constituents further comprise one or more emulsifier.

35. The method of claim **27**, wherein the matrix constituents further comprise one or more plasticizer.

36. The method of claim **27**, further comprising adjusting a pH of the matrix suspension to a range of about pH 4 to about pH 9 using a feed-grade acid or a feed-grade base.

37. The method of claim **27**, wherein dissolving or suspending the matrix constituents takes place at a temperature from about 10°C to about 60°C.

38. The method of claim **27**, wherein the lipids comprise one or more oils, fats, monoglycerides, diglycerides, free fatty acids, phospholipids, or triglycerides.

39. The method of claim **27**, wherein the lipids in the filler composition comprise about 25% or more of conjugated linoleic acid.

40. The method of claim **27**, wherein the lipids comprise fatty acids selected from the group consisting of oleic acid, conjugated linoleic acid, conjugated linolenic

acid, phytanic acid, omega 3 fatty acids, docosahexaenoic acid, and eicosapentaenoic acid.

41. The method of claim **27**, wherein the emulsion comprises about 30% lipid and about 15% protein by weight.

42. The method of claim **27**, further comprising modulating lipid biosynthesis of a ruminant by introducing substrates in the composite gel.

43. The method of claim **42**, wherein the substrate comprises a C18:3 fatty acid and the lipid biosynthesis produces a C20:5 fatty acid.

44. The method of claim **43**, further comprising creating eicosanoids from the C20:5 fatty acid, which eicosanoids are selected from the group consisting of: a prostaglandin, a thromboxane, a leukotriene, and a lipoxin.

45. The method of claim **27**, wherein emulsifying comprises mixing the filler composition and the matrix suspension with a high shear homogenizer, a colloidal mill, a high-speed mixer, a high pressure homogenizer, or a sonicator.

46. The method of claim **27**, wherein the emulsifying yields an emulsion with a mean lipid droplet size ranging from about 1 μm to about 100 μm.

47. The method of claim **27**, wherein the emulsifying yields an emulsion with a lipid droplet specific surface area of greater than about 10 m^2/ml of filler phase.

48. The method of claim **27**, further comprising treating the emulsion with a high pressure homogenizer, at a pressure ranging from about 5 MPa to about 75 MPa to yield an emulsion with a mean lipid droplet size ranging from about 0.1 μm to about 10 μm.

49. The method of claim **27**, further comprising adding additional constituents after emulsifying the filler composition into the matrix suspension.

50. The method of claim **27**, further comprising heating the matrix suspension or the emulsion to a temperature of about 70°C to about 95°C and holding at the temperature for about 10 minutes to about 45 minutes.

51. The method of claim **27**, further comprising holding the emulsion for about 0.5 hours to about 24 hours at a temperature from about 4°C to about 50°C.

52. The method of claim **27**, further comprising filling the emulsion into a heat resistant container.

53. The method of claim **27**, wherein said heating comprises holding the emulsion for about 20 minutes to about 180 minutes at a temperature of about 80°C to about 125°C.

54. The method of claim **27**, wherein said heating comprises holding the emulsion for about 2 hours at a temperature of about 120°C.

55. The method of claim **27**, wherein heating comprises heating the emulsion in a sealed container.

56. The method of claim **27**, further comprising:

feeding the composite gel to a ruminant; and,

milking the ruminant, thereby collecting milk with modified lipid characteristics.

57. The method of claim **56**, wherein the filler lipid comprises about 25% or more linoleic acid by weight.

58. The method of claim **56**, wherein the filler lipid comprises oil selected from the group consisting of: corn oil, poppy seed oil, fish oil, cotton seed oil, soybean oil, walnut oil, safflower oil, sunflower oil, sesame oil, canola oil, linseed oil, whole or modified oil seed, whole or modified beans, grape seeds, cotton seeds, safflower seeds, algae, microorganisms, yeasts, and protozoa.

59. The method of claim **56**, wherein the filler lipid comprises fatty acids selected from the group consisting of: oleic acid, conjugated linoleic acid, phytanic acid, omega 3 fatty acids, docosahexaenoic acid, and eicosapentaenoic acid.

60. The method of claim **56**, further comprising processing the milk to prepare a dairy product.

61. A method of administering one or more supplemental constituents or one or more lipids to a ruminant, the method comprising:

admixing the supplemental constituents or lipids with a matrix suspension or a filler composition;

preparing a rumen protected composite gel comprising the matrix suspension or the filler composition; and,

feeding the composite gel to the ruminant;

wherein the supplemental constituents or lipids pass through the rumen, and the supplemental constituents or lipids are released from the composite gel in an effective amount subsequent to passing through the rumen.

62. The method of claim **61**, wherein the feed supplements are selected from the group consisting of vitamins, minerals, hormones, nutrients, amino acids, proteins, polyunsaturated lipids, bio-active materials, and pharmaceuticals.

63. The method of claim **61**, wherein the matrix constituents do not comprise reducing sugars in an amount effective to significantly cross-link matrix proteins under the conditions of the method.

64. The method of claim **61**, wherein said admixing comprises emulsifying the filler composition into the matrix suspension, thereby producing filler composition droplets comprising an average size between about 0.1 μm and 1 μm.

65. The method of claim **64**, wherein said admixing comprises emulsifying the filler composition into the matrix suspension, thereby producing filler composition droplets comprising a specific surface area greater than about 10 m^2/ml of filler.

66. The method of claim **61**, wherein said preparing comprises heating the matrix suspension or the filler composition in a sealed container.